

ABSTRACT

Lapindo mud has the potential to be used as a raw material for functional components due to its high aluminum oxide (Al_2O_3) content. However, the $\gamma\text{-Al}_2\text{O}_3$ phase has a wide band gap energy (3.21–6.7 eV), which limits its photocatalytic activity under visible light. This study aims to synthesize a $\text{CuO}/\gamma\text{-Al}_2\text{O}_3$ composite using Al_2O_3 extracted from Lapindo mud by incorporating CuO, which has a narrow band gap. The synthesis was conducted using a hydrothermal method with variations in the Cu:Al molar ratio (0.5:1; 1:1; 1.5:1; 2:1; 1:0; and 0:1) and the addition of stearic acid as a capping agent. The extracted Al_2O_3 content was confirmed via XRF analysis, while the synthesized composites were characterized using FTIR, XRD, and UV-Vis DRS. The photocatalytic performance was evaluated through the degradation of Methylene Blue (MB) solution under visible light irradiation for 240 minutes. FTIR analysis confirmed the successful formation of the $\text{CuO}/\gamma\text{-Al}_2\text{O}_3$ composite. XRD characterization showed crystallite sizes ranging from 15.40 to 22.92 nm with 50–64% crystallinity. All composites exhibited band gap energies ranging from 1.55 to 2.41 eV, indicating that the materials are highly active in the visible light region. Photocatalytic evaluation revealed that the composite with a Cu:Al ratio of 1:1 (CA-1) achieved the highest MB degradation efficiency of 38% in 240 minutes. The photodegradation kinetics followed a pseudo-second-order model with a rate constant (k_2) of $0.0004 \text{ L}\cdot\text{mg}^{-1}\cdot\text{min}^{-1}$. This study demonstrates that the Lapindo mud-based $\text{CuO}/\gamma\text{-Al}_2\text{O}_3$ composite has the potential to be an efficient alternative photocatalyst for organic waste treatment, simultaneously providing a value-added solution for environmental waste utilization.

Keywords: *Lapindo mud, $\gamma\text{-Al}_2\text{O}_3$, CuO, composite, photocatalyst, Methylene Blue, hydrothermal..*